Lecture 2:

Idea on Ecosystem-based Management (EBM)

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(PICES WG19: Ecosystem-based Management Science)

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1. The basic concepts of EBM

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- There are many ways to enjoy the natural blessings from the sea.

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E.g. Swimming and bathing

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E.g. Diving

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E.g. Angling / gathering

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E.g. Cruising / Sight seeing

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E.g. Motor sports

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E.g. Dinning

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- Also, there are other uses of the ocean, such as

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E.g. Education

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E.g. Reclamation (landfill) and Development

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And fisheries

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Human and the ocean

- We now have a much greater appreciation of how the oceans support and sustain human life by providing services.
- Such as

  seafood; medicine; nutrient cycling; water purification; protection of shores from erosion and storm damage; moderation of climate and weather; recreation; and spiritual, religious, and other nonmaterial benefits.

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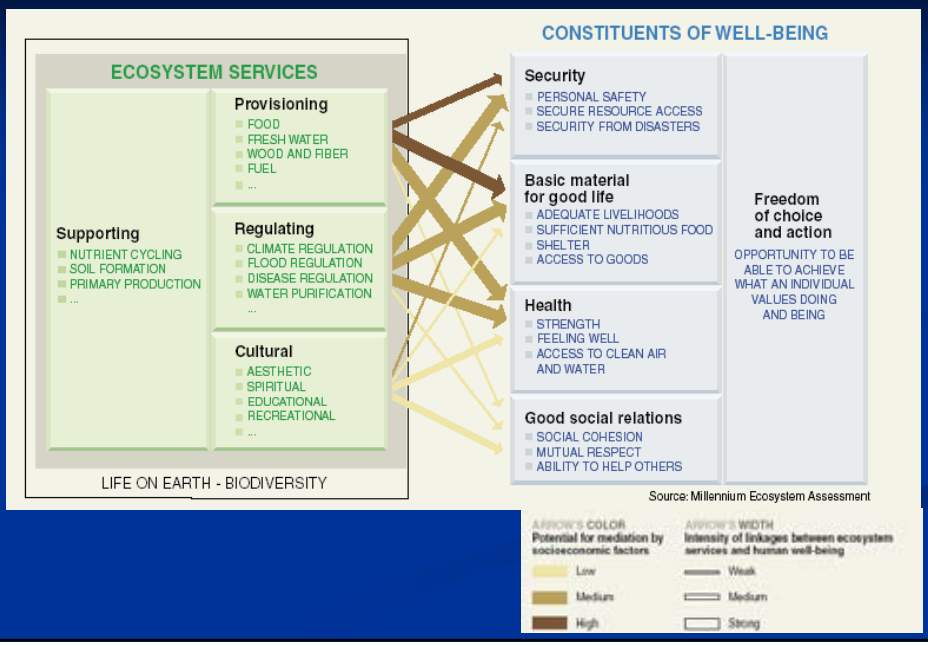
Ecosystem services and well-being

(MA2004)



What is the issues ?

- The scientific understanding of marine ecosystems has advanced considerably over the last few decades.
- It has been gradually clear that a combination of human activities on land, along the coasts, and in the ocean are unintentionally but seriously affecting marine ecosystems by altering marine food webs, changing the climate, damaging habitat, eroding coastlines, introducing invasive species, and polluting coastal waters.

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What is the issues ? (cont.)

- However, each policy responses or measure is typically considered in isolation; i.e., coordinated management of cumulative impacts is rare (isolated laws/acts and measures, ministries/agencies, no big picture and close linkages).

EBM is the cornerstone of a new vision

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The basic concepts of EBM

(Scientific Consensus Statement on Marine Ecosystem-Based Management, 2005)

- **An integrated approach to management that considers the entire ecosystem, including humans.**
- **The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need.**

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- Then, what have we known about the Ecosystems? What is the sustainability of an Ecosystem? → Lecture 5
- What is the core scientific knowledge about ecosystems from the view point of their appropriate use and management?

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Key characteristics of ecosystems for the design of management policy (1)

- Ecosystems are highly interactive and linked.

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Shiretoko World Natural Heritage

- One of Japan's most beautiful and unspoiled peninsula. Very popular for sightseeing.
- No roads lead to the peninsula, and the northern tip can only be viewed from boats or be reached on multi day trekking.

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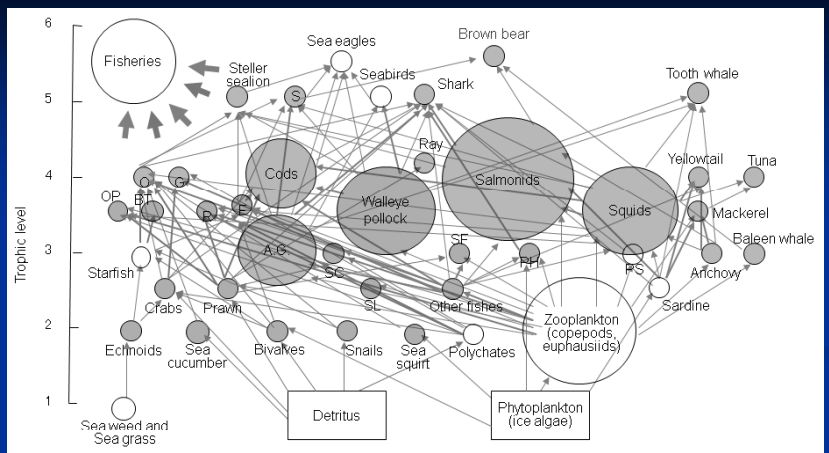
Nature of Shiretoko

- The peninsula is home to a variety of wildlife, including brown bears, dear, foxes, and sea mammals.
- In winter, the peninsula's coast is surrounded by drift ice.

http://www.gt-works.com/yachoo/23kan/tori/taka/oowasi.htm



Food web of the Shiretoko Heritage site

(depicted by the Marine Area Working Group of the Scientific Council).
Species common name for abbreviations: AG:. Arabesque greenling, BT: Bighand thornyhead, F: Flatfishes, G Greenlings, O Octopus, OP: Ocean perch, PH: Pacific herring, PS: Pacific saury, R: Rockfish, S: Seals, SC: Saffron cod, SF: Sandfish, SL: Sand-lance.

Key characteristics of ecosystems for the design of management policy (1)

- Ecosystems are highly interactive and linked.
- However, not all interactions are equally important.

e.g. the absense of large-bodied predators at the apex of food webs can result in large-scale changes of other species.

→ Management policy should entail identifying and focusing on the role of key interactions, rather than on all possible interactions. (Modeling tools such as NEMURO)

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Key characteristics of ecosystems for the design of management policy (2)

- Ecosystems are dynamic and uncertain.
- It is inherently difficult to predict, esp. over longer time period

e.g. decadal-scale changes (such as the Pacific Decadal Oscillation) significantly alter ecosystem dynamics and population sizes. Such long-term changes tend to be less predictable because they are associated with large-scale environmental changes.

→ Management policy must thus anticipate and be adaptive to these changes. (Risk theory in Lecture 3)

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Key characteristics of ecosystems for the design of management policy (3)

- Ecosystems can recover from many kinds of disturbances.
- However, they are not infinitely resilient.

(There is some threshold beyond which an altered ecosystem may not return to the previous state)

- Very often, the tipping point is difficult to predict.

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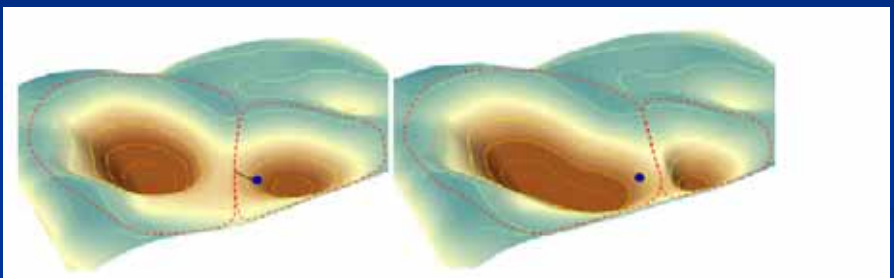
Idea of resilience



Three-dimensional stability landscape with two basins of attraction showing the current position of the system (the 'ball') and how it can shift regimes as the stability landscape changes

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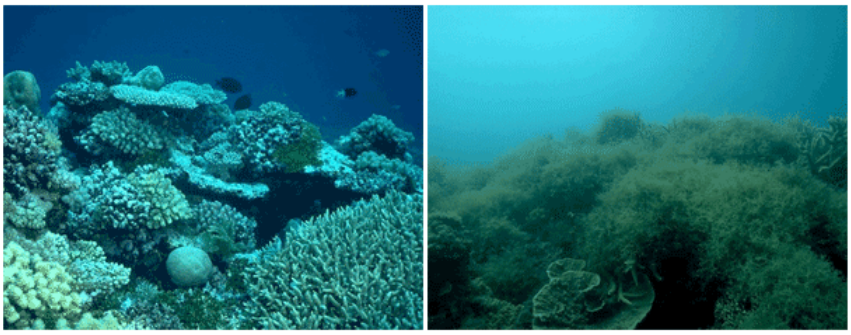
CATASTROPHIC SHIFTS IN ECOSYSTEMS



Coral Dominance > > > > Algal Dominance

http://www.resalliance.org

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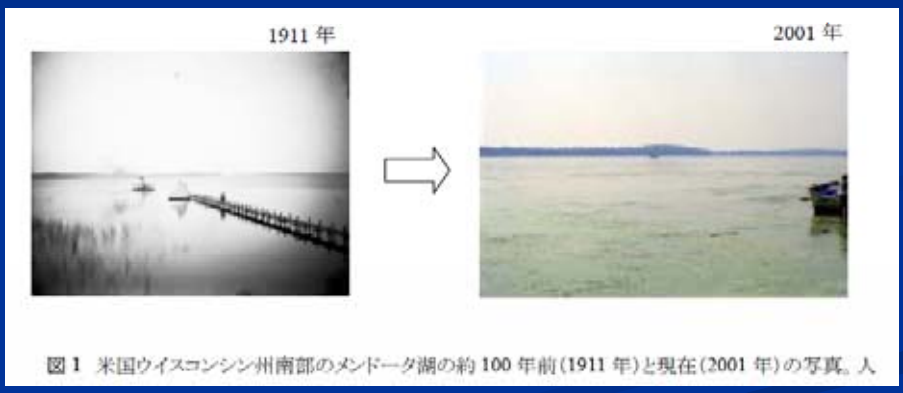

図 1　米国ウイスコンシン州南部のメンドータ湖の約 100 年前（1911 年）と現在（2001 年）の写真。人

Blue-green algae covered the lake surface in Wisconsin, USA.

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Key characteristics of ecosystems for the design of management policy (3)

- Ecosystems can recover from many kinds of disturbances.
- However, they are not infinitely resilient.

(There is some threshold beyond which an altered ecosystem may not return to the previous state)

- Very often, the tipping point is difficult to predict.

→ Management policy must thus be precautious.

(Precautionary Principle on Lecture 3).

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Key characteristics of ecosystems for the design of management policy (4)

- Ecosystem services are nearly always undervalued.
- Many essential services are neither appreciated nor assigned economic worth.

(e.g. nutrient recycling, control of desease and pests, climate regulation, cultural heritage and spiritual benegits)

→ Management policy must take these non-valued services into account (e.g. ecological footprint, Contingent Valuation Method).

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Key characteristics of ecosystems for the design of management policy (5)

- Only the society can decide the desired/healthy state of ecosystems.
- As there are many services conferred from an ecosystem, there are many stakeholders for its management. Each actor values some part of ecosystem more valuable than others (NO UNIQUE SOLUTION).

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The basic concepts of EBM

(Scientific Consensus Statement on Marine Ecosystem-Based Management, 2005)

- **An integrated approach to management that considers the entire ecosystem, including humans.**
- **The goal of ecosystem-based management is to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans want and need.**

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Key characteristics of ecosystems for the design of management policy (5)

- Only the society can decide the desired/healthy state of ecosystems.
- As there are many services conferred from an ecosystem, there are many stakeholders for its management (NO UNIQUE SOLUTION)

→ Management policy must take wide range of stakeholders into decision-making process, and its objective is a societal choice.

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To sum up, the EBM should

- entail identifying and focusing on the role of key interactions, rather than on all possible interactions.
- anticipate and be adaptive to changes.
- be precautious.
- take these non-valued services into account.
- take wide range of stakeholders into decision-making process, so as to be a societal choice.

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There are similar terms

- Ecosystem management (EM)
- Ecosystem-based management (EBM)
- Ecosystem-based fisheries management (EBFM)

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Key features of EBFM

- In addition to the traditional single-species-based fisheries management,

1. Species interaction
2. Bycatch species
3. Threatened or protected species
4. Habitat management
5. Trophic structure managemetnt
6. Physical environment
7. Pollutants
8. Aquaculture

For more detail, Lecture 4 by Prof. Zhang

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Rationale for implementing EBM

- Management that emphasizes the protection of ecosystem structure, functioning, and key processes is much more likely to ensure the long-term delivery of these important services.

- From a policy perspective, implementation of EBM will enable more coordinated and sustainable management of activities that affect the oceans.

→ EMB should reduce duplication and conflicts, and in the long run, cost-effective.

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1. The basic concepts of EBM
2. Legal documents regarding EBM
3. Procedure for EBM
4. Indicators for EBM

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Convention on the Conservation of Antarctic Marine Living Resources: CCAMLR (1980)

ARTICLE II

3. Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the provisions of this Convention and with the following principles of conservation:

(c) prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, …, with the aim of making possible the sustained conservation of Antarctic marine living resources.

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Rio Declaration on Environment and Development (1992)

- Principle 7

States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities.

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FAO CoC for Responsible Fisheries (1995)

6 - GENERAL PRINCIPLES

6.1 States and users of living aquatic resources should conserve aquatic ecosystems.

6.2 …. Management measures should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with or dependent upon the target species.

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CBD COP 2 decision : Marine and Coastal Protected Areas (Jakarta Mandate 1995)

- The establishment and maintenance of marine and coastal protected areas (is) to maintain the structure and functioning of the full range of marine and coastal ecosystems, in order to provide benefits to both present and future generations.

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Under these international legal conditions

- (T)he obligation to adopt an ecosystem (based) approach to the management of the marine environment and resources has been established in international law.

(Wang H. 2004. Ecosystem Management and Its Application to Large Marine Ecosystems: Science, Law, and Politics , *Ocean Development and International Law*, 35: 41-74)

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An example of possible procedure for EBM :

(based on Pacific States Marine Fisheries Commission 2005, The Nature Conservancy 2007, Resilience Alliance 2007)

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- Step 1 :Define the management goals to reflect the societal objectives

  Delineate and characterize the ecosystem you are interested as a social-ecological system, and define the goals.

- Step 2: Develop a conceptual model of the social-ecological system

  Including the influence of oceanographic and climatic factors, life history characteristics and/or spatial variation.

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- Step 3: Identify threats and human use

  Current impacts and future risks (threats) are factors that affect the process, function, and structure of an ecosystem.

- Step 4: Develop databases

  Identify the available long-term monitoring data and how they are used to estimate parameters for the model.

- Step 5: Assess the uncertainty

  What kind of uncertainties in the model? What kind of buffers against uncertainty are needed? What kind of data/knowledge gaps in the model?

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- Step 6: Develop indicators for management (Lecture 1, and the next section of this lecture)
- Step 7: Delineate management policy based on models and indicators.
- Step 8: Implement it, monitor and assess the results based on changes in indicators.
- Go to Step 1 (goal setting) or 2 (conceptual model) and revise.

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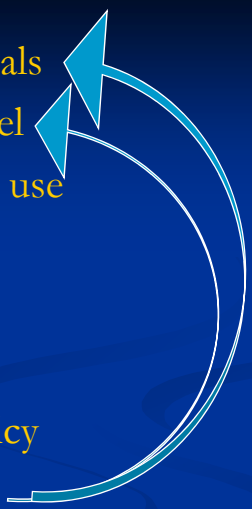
1. Define the management goals
2. Develop a conceptual model
3. Identify threats and human use
4. Develop databases
5. Assess the uncertainty
6. Develop indicators
7. Delineate management policy
8. Implement and monitor



There is no international consensus on the procedure of EBM.

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(based on works by PICES WG19)

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Why we need indicators for EBM?

- There is an academic journal, *Ecological Indicators*.
- To reduce the complexity of social-ecological systems to an ideally small set of synthetic indices.
- To provide direction, and to measure the progress of management towards the EBM objectives.
- In human health, an analogy is body temperature and heart (pulse) rate which allows a rapid assessment of immediate condition.

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No single indicator describes all aspects of ecosystem dynamics

Eg.

- environmental and low-trophic-level indicators capture environmental change and bottom-up effects.
- high-trophic-level indicators (e.g. birds, marine mammals) summarise changes in fish communities.
- size-based indicators are promising for characterizing fish community dynamics in a context of overexploitation.

A suite of indicators are needed (covering different data, groups, processes, and objectives).

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Also, there are classes of indicators

- 'contextual' and 'management' indicators.

→ Contextual means background conditions over which humans have no control, at least in a short time such as years or decades (descriptive). Mgmt should be applicable to measure the results

- 'ecological' and 'social' indicators

(Lecture 1: EF and HDI)

→ Ecological relates to marine environment and biological aspects. Social is to human welfare

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For Ecosystem-based Fisheries Management

- consensus is emerging on a core set of ecosystem indicators, such as

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1	Relative biomass	•e.g. of gelatinous zooplankton, cephalopods, small pelagics, scavengers, demersals, piscivores, top predators
2	Biomass ratios	•piscivore:planktivore; pelagic:demersal; infauna:epifauna
3	Habitat-forming taxa	•e.g. proportional area covered by these epifauna and/or macrophytes
4	Size spectra	•slopes of community size spectra and their changes can be particularly strong indicators of community level changes
5	Taxonomic diversity (Richness)	•e.g. based on species counts
6	Total fishery removals	•catch + discards + bycatch
7	Maximum (or mean) length	•maximum (or mean) length across all species in the catch
8	Size-at-maturity	•e.g. of main target species, bycatch, and top predators
9	Trophic level or trophic spectrum of the catch	•average trophic level or spectra of the catch (e.g. Gascuel et al. 2005) (may require that diet data be updated periodically)
10	Biophysical characteristics	•e.g. temperature, salinity, sea ice (where present), chlorophyll a, primary production, atmospheric indices (e.g. PDO).

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For Ecosystem-based Fisheries Management

- consensus is emerging on a core set of ecosystem indicators, such as

Relative biomass, Biomass ratios, Habitat-forming taxa, Size spectra, Taxonomic diversity (Richness), Total fishery removals, Maximum (or mean) length, Size-at-maturity, Trophic level or trophic spectrum of the catch, Biophysical characteristics, etc.

PICES is now discussing the indicators for social aspects (S12 of the PICES XVII @ Dalian).

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Summary of the lecture 2

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Human and the ocean

- We have been enjoying wide ranging ecosystem services from the ocean, but the combination of human activities are unintentionally but seriously affecting marine ecosystems.
- Conventional policy responses or measures are typically considered in isolation and not coordinated.

EBM is the cornerstone of a new vision

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Under today's international legal conditions

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An example of possible procedure for EBM

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2. Develop a conceptual model
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5. Assess the uncertainty
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7. Delineate management policy
8. Implement and monitor

There is no international consensus on the procedure of EBM.

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We need indicators for EBM

- To reduce the complexity, to provide direction, and to measure the progresses of EBM.
- No single indicator describes all aspects of ecosystem dynamics. A suite of indicators are needed (covering different data, groups, processes, and objectives).
- For Ecosystem-based Fisheries Management, consensus is emerging on a core set of ecological indicators. Social indicators are now under discussion.

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Suggested Reading :

Scientific Consensus Statement on Marine EBM (2005).

- Visit the COMPASS (Communication Partnership for Science and the Sea) Website.
- COMPASS is a group of marine scientists to advance and communicate scientific knowledge to policymakers.
- From PICES WG19, Dr.s David Fluharty and Gordon Kruse signed on this consensus statement.

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www.compassonline.org

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For advanced learners

- Christensen, N.L., et al. 1996. The report of the Ecological Society of America committee on the scientific basis for ecosystem management. *Ecological Applications* 6:665-691.
- Costanza, R., et al. 1998. Principles of sustainable governance of the oceans. *Science* 281:198-199.
- Link, J.S. 2002. What does ecosystem-based fisheries management mean? *Fisheries* 27:18-21.
- Pikitch, E.K., et al. 2004. Ecosystem-based fishery management. *Science* 305:346-347.
- *Millennium Ecosystem Assessment*. 2005. Island Press, Washington DC.

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Desired properties of EBM indicators (Rice and Rochet, 2005)

- Concreteness
- Theoretical basis
- Public awareness
- Cost
- Measurement
- Availability of historical data
- Sensitivity
- Responsiveness
- Specificity

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